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(54) A METHOD AND APPARATUS FOR TRANSMITTING PRECODING MARTRIX INDEX AND PERFORMING PRECODING

VERFAHREN UND VORRICHTUNG ZUR ÜBERTRAGUNG EINES VORKODIERUNGSMATRIX-INDEXES UND ZUR DURCHFÜHRUNG EINER VORKODIERUNG

PROCÉDÉ ET DISPOSITIF POUR LA TRANSMISSION D'UN INDICE DE MATRICE DE PRÉCODAGE ET LA RÉALISATION DU PRÉCODAGE

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- **HUAWEI: "Extensions to Rel-8 type CQI/PMI/RI feedback using double codebook structure", 3GPP DRAFT; R1-100251, vol. RAN WG1, no. Valencia, Spain; 20100118, 12 January 2010 (2010-01-12), XP050417935, Spain**

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of communication technology, and more specifically, to a method and apparatus for PMI (Precoding matrix Index) transmission and precoding.

DESCRIPTION OF THE RELATED ART

[0002] In 3GPP (3rd Generation Partnership Project) LTE (Long Term Evolution) R10, eight antennas are introduced into a BS (Base Station). There are two configurations for antenna arrangement: a ULA antenna configuration as shown in Fig.1, and a bipolarization antenna configuration as shown in Fig.2. With respect to discussions about current 8-antenna codebooks in 3GPP, there is an agreement as follows. Current precoding is composed of two sections:

$$W = W_1 W_2 \tag{1}$$

wherein, W_1 belongs to a codebook set C_1, W_2 belongs to another codebook set C_2. W_1 mainly represents a wide-band/long-term channel characteristic; W_2 represents a subband/short-term channel characteristic.

[0003] In 3GPP LTE R8, PMI (Precoding Matrix Index) information can be reported over PUCCH (Physical Uplink control CHannel) or PUSCH (Physical Uplink Shared CHannel), wherein PMI information includes at most 4 bits.

[0004] In the prior art, it is unable to achieve flexible configuration or utilization of PMI according to transmission channel conditions.

[0005] Huawei:"Downlink 8TX codebook considerations", 3GPP DRAFT; R1-100256, vol. RAN WG1, no. Valencia, Spain, 20100118, 12 January 2010 (2010-01-12), XP050417939 relates to a double codebook structure for the eight antenna eNB that is designed for the most likely use case of dual polarized antenna arrays and that allows for an efficient use of feedback overhead bits by handling the parts with low and high coherence bandwidths separately.

[0006] Huawei:" Extensions to Rel-8 type CQI/PMI/RI feedback using double codebook structure", 3GPP DRAFT; R1-100251, vol. RAN WG1, no. Valencia, Spain, 20100118, 12 January 2010 (2010-01-12), XP050417935 relates to principles of a codebook of precoding matrices and reporting of a preferred precoding matrix and rank together with the associated CQI per codeword, and the double codebook feedback structure.

SUMMARY OF THE INVENTION

[0007] The above objects are solved by the claimed subject matter according to the independent claims. Preferred embodiments are provided in the dependent claims. The present invention is defined and limited only by the scope of the appended claims. In the following, any embodiment(s) referred to and not falling within the scope of said appended claims is (are) to be interpreted as example(s) useful for understanding the present invention. In view of above aspects of this invention, precoding matrixes having different accuracies can be selected according to the capability of the transmission channel to carry PMI to perform precoding on data transmitted from the BS to the UE, so as to achieve flexible configuration and utilization of PMI.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig.1 is a schematic structural diagram of a ULA antenna in the prior art;
Fig.2 is a schematic structural diagram of a bipolarization antenna in the prior art;
Fig.3 is a flowchart of a method for transmitting PMI according to an embodiment of this invention;
Fig.4 is a flowchart of a precoding method according to an embodiment of this invention;
Fig.5 is a schematic structural diagram of a UE according to an embodiment of this invention;
Fig.6 is a schematic structural diagram of a BS according to an embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0009] A clear, complete description will be given to technical solutions of embodiments of this invention in connection with accompanying drawings of embodiments of this invention. Obviously, embodiments described herein are merely some embodiments of this invention, but not all of them. Based on those embodiments of this invention, other embodiments can occur to those skilled in the art without any creative efforts, all of which fall within the scope of this invention.

[0010] Fig.3 is a flowchart of a method for transmitting PMI according to an embodiment of this invention, including the following steps.

[0011] Step 301. A UE acquires a capability of a transmission channel to carry PMI.

[0012] In this embodiment, the transmission channel refers to a channel carrying or bearing PMI, for example, including: a PUCCH channel, a PUSCH channel, etc. The way to acquire the capability of the transmission channel to carry PMI may include: receiving a signaling for notifying PMI carrying capability of the transmission channel sent from a BS, or acquiring from a locally stored list of the capability of the transmission channel to carry PMI. The capability of a transmission channel to carry PMI refers to the maximum number of bits for carrying PMI on the transmission channel, for example, on a PUCCH channel at most 4 bits for carrying PMI, on a PUSCH channel at most 6 bits for carrying PMI. Such capability can be preconfigured according to data transmission requirements.

[0013] Optionally, at step 302, according to the capability of the transmission channel to carry PMI, the UE can select a precoding matrix from a first codebook set locally stored to form a second codebook set.

[0014] Particularly, all or a subset of the first codebook set can be selected as the second codebook set according to actual transmission channel conditions. The first codebook set may be a set of all codebooks used for precoding in UE data transmission and locally stored by the BS or the UE, separately.

[0015] The precoding matrix of the first codebook set may be in the form as follows.

$$\mathbf{W} = \underbrace{\begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}}_{\mathbf{W}_1} \underbrace{\begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}}_{\mathbf{W}_2} \qquad (2)$$

[0016] In equation (2), assume the number of transmitting antennas is N_t(N_t is an even), the rank of the matrix is R, W_1 is a $N_t \times 2R$ matrix, W_2 is a $2R \times R$ matrix. I is a $R \times R$ identity matrix, X is a $R \times R$ diagonal matrix, D is a $N_t/2 \times N_t/2$ diagonal matrix, A is a $N_t/2 \times R$ matrix, Λ is a $R \times R$ diagonal matrix. Wherein,

$$\mathbf{\Lambda} = \begin{bmatrix} a_1 & 0 & 0 \\ 0 & \ddots & \mathbf{0} \\ 0 & 0 & a_R \end{bmatrix} \quad \mathbf{X} = \begin{bmatrix} \beta_1 & 0 & 0 \\ 0 & \ddots & \mathbf{0} \\ 0 & 0 & \beta_R \end{bmatrix} \qquad (3)$$

[0017] As to the bipolarization antennas shown in Fig.2, Λ and X are used to adjust the phase relationship between two sets of polarized antennas. α_i, β_i(i=1,...R) are scalars having modulus of 1.

[0018] Taking 8 transmit antennas and a precoding matrix having rank of 1 as an example, in the arrangement shown in Fig.2, D is a 4*4 diagonal matrix, which can be represented with b bits, there are $T=2^b$ possible values.

$$\mathbf{D} \in \left\{ \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\pi g/8} & 0 & 0 \\ 0 & 0 & e^{2j\pi g/8} & 0 \\ 0 & 0 & 0 & e^{3j\pi g/8} \end{pmatrix} \right\}, \left(g \in 0, \ldots T-1\right) \qquad (4)$$

[0019] A can be obtained from an existing DFT (Discrete Fourier Transform) based codebook structure through the following equation.

$$\mathbf{e}_m^{(g)} = \frac{1}{\sqrt{M}}\left[w_{0m}^{(g)} \quad \dots \quad w_{(M-1)m}^{(g)}\right]^{\mathrm{T}}$$
$$w_{nm}^{(g)} = \exp\left\{j\frac{2\pi n}{M}\left(m+\frac{g}{G}\right)\right\} \qquad (5)$$

[0020] Wherein, M is the number of DFT dimensions, m=0, 1,...M-1; n=0, 1...M-1. As to DFT corresponding to 4 antennas, M=4. G is the number of groups of DFT, g=0, 1,..., G-1. $e_m^{(g)}$ is a precoding vector in the codebook set, $w_{nm}^{(g)}$ represents various elements in $e_m^{(g)}$. For instance, in the case of G=2, four 4×1 precoding vectors can be obtained from each 4-dimensional DFT structure, and two DFT structures may produce eight 4×1 precoding vectors. Hence, if A is represented with 3 bits, the values of A can be obtained from the eight 4×1 precoding vectors. A is a 1×1 matrix with values of points on a unit circle, and represented with b bits, for example. Thus, there are total $T=2^b$ possible values and its value can be $e^{j2\pi k/T}$ (k=0,..., T-1). For example, with a 1-bit representation, it has values (1,-1). A and X are both 1×1 matrix with their values of points on a unit circle and represented with b bits, for example. Thus, there are total $T=2^b$ possible values and their value can be $e^{j2\pi k/T}$ (k=0,..., T-1).

[0021] Suppose that the first codebook set is represented with 7 bits. Because the function of D, A is to adjust the direction of beam transmission, they are totally represented with 5 bits. Assume that D is represented with 1 bit, in equation (3), g is set to 1 or -1 constantly.

$$\mathbf{D} \in \left\{ \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\pi g/8} & 0 & 0 \\ 0 & 0 & e^{2j\pi g/8} & 0 \\ 0 & 0 & 0 & e^{3j\pi g/8} \end{pmatrix} \right\} \qquad (6)$$

[0022] A is represented with 4 bits. Because both Λ, X represent phase adjustments between two sets of antennas with different polarizations, they can be represented with 2 bits in total.

[0023] Through adjusting the bit numbers of D, A, Λ, X, the total number of bits of PMI can accord to carrying capability of a transmission channel. "Accord to" as mentioned herein means that the total number of bits representing D, A, Λ, X is identical to the number of bits that the transmission channel can transmit. For example, on a PUCCH channel, if PMI can be transmitted in at most 4 bits, the total number of bits of D, A, Λ, X is 4. It can be provided for the UE to have a constant D=I (identity matrix), X=I. If 3 bits are set for A and 1bit for A, the PMI has total 4 bits. If the PMI is transmitted through PUSCH, the PMI may have 6 bits and the total number of bits of D, A, A, X is 6. In this context, D may be represented with 1 bit and A may be set to I. A can be represented with 3 bits, X in 2 bits, and thus 6 bits in total. If a 7-bit PMI is transmitted on PUSCH, A can be represented with 4 bits, D with 1 bit, and X with 2 bits. A second codebook set is selected from the first codebook set. When the second codebook set is a subset of the first codebook set, the selecting criteria of the second codebook set focuses on partitioning the signal space as uniform as possible. For example, if the first codebook set includes 7bits in total, while the second codebook set only can be represented with 4bits, we can have that D=I, A can be represented with 3 bits, indicating 8 directions (the first codebook set may indicate 32 directions). In equation (5), make g=0, g=2, G=4, 8 approximately uniform directions can be obtained. Let X=I at the same time (or Λ =I, X is represented with 1 bit), Λ is represented with 1 bit, with a range of values of 1 or -1 (in the case of 2 bits, a range of 1, -1, j, -j).

[0024] Optionally, in this step, the UE can directly select a codebook set suitable for the capability of the transmission channel to carry PMI as the second codebook set described above according to the carrying capability, as detailed in the following method embodiment of this invention.

[0025] Step 303. The UE selects a first precoding matrix for BS precoding according to the second codebook set.

[0026] When the UE selects precoding from the second codebook set, the selection can be made according to some specified criteria. References can be made to the prior art for particular selection criteria. For example, a precoding matrix leading to the maximum SNR of data can be selected as the first precoding matrix.

[0027] Step 304. An index corresponding to the first precoding matrix is sent to the BS over the transmission channel.

[0028] Because the index of the selected precoding matrix needs to be transmitted over the transmission channel, different precoding matrixes in the second codebook set can correspond to different index respectively, so as to represent those different precoding matrixes distinguishingly. The index corresponding to the first precoding matrix refers to, after the index has been established for precoding matrixes in the second codebook set, an index item corresponding to the first precoding matrix in the established index. For example, when PUCCH is used as the transmission channel, if the first codebook set comprises 32 codebook matrixes, and if PUCCH can use merely 4 bits for PMI transmission, then 16 codebook matrixes can be selected from the first codebook set to form the second codebook set, and 0-15 (represented with 4bits) can be used as index of the above 16 codebook matrix. If a codebook matrix with index item 0 is selected as the first precoding matrix described above, the index item corresponding to the first precoding matrix can be represented as 0000; or if a codebook matrix of number 2 is selected as the first precoding matrix described above, the index item corresponding to the first precoding matrix can be represented as 0010.

[0029] In this embodiment, after the UE acquires transmission channel capability, a codebook set can be configured according to the channel capability, and PMI can be feedback to the BS, so that the BS can obtain PMI with different accuracies depending on carrying capabilities of UE transmission channels.

[0030] In another embodiment of this invention, the above method may further include:

Providing different sets of codebooks according to different the capabilities of the transmission channels to carry PMI in advanced, the selecting action at step 302 in the above embodiment can be omitted. That is, there are several different codebook sets provided to be selected by the UE in an original state, for example, the first codebook set and the second codebook set described above. This method differs from that of the above embodiment in that instead of selecting the second codebook set from the first codebook set, the first codebook set or the second codebook set can be selected directly according to the capabilities of the transmission channels to carry PMI.

[0031] Fig.4 is a flowchart of a precoding method according to an embodiment of this invention, including the following steps.

[0032] Step 401. A BS receives an index corresponding to a first precoding matrix transmitted by a UE over a transmission channel.

[0033] In this embodiment, the first precoding matrix is selected from a second codebook set, and the second codebook set is formed from precoding matrixes selected from the first codebook set stored locally on the UE. A reference can be made to the corresponding description in embodiment shown in Fig.3 for the particular way of obtaining the second codebook set.

[0034] Step 402. The BS finds out the first precoding matrix according to the index corresponding to the first precoding matrix.

[0035] In this embodiment, the first precoding matrix can be found from a third codebook set locally stored according to the index, and then precoding can be performed on data according to the first precoding matrix, wherein the third codebook set is identical to the second codebook set. The term "identical" used herein means that the third codebook set contains the same items of precoding matrixes as the second codebook set does, and the precoding matrices contained in the third codebook set are the same as those contained in the second codebook set, and the same index item represents the same precoding matrix in the third codebook set and the second codebook set.

[0036] In this embodiment, the third codebook set may be predetermined by the BS according to the capability of the transmission channel to carry PMI or the type of the transmission channel. The way of establishing indexes corresponding to various precoding matrixes in the third codebook set is substantially the same as that of the embodiment shown in Fig.3, which will not be repeated herein.

[0037] Step 403. The BS performs precoding using the precoding matrix obtained in step 403.

[0038] In this embodiment, the BS performs precoding on data sent to the UE using the PMI which fed back from the UE. Depending on different carrying capabilities of UE transmission channels, precoding matrixes with different accuracies can be obtained, so that flexible PMI configuration can be guaranteed and rational use of transmission channel resources can achieved.

[0039] Those skilled in the art may understand: some or all steps of the method of the above described embodiment can be realized with programs and instruction related hardware, the programs can be stored in a computer readable storage medium, such as, ROM/RAM, a magnetic disk, an optical disc, etc.

[0040] Fig.5 is a schematic structural diagram of a UE according to an embodiment of this invention, which can realize the method provided in the above embodiment, the UE including:

an acquiring unit 501, configured to acquire the capability of the transmission channel to carry PMI;
a selecting unit 502, configured to select precoding matrixes from a first codebook set locally stored to form a second codebook set according to the capability of the transmission channel to carry PMI acquired by the acquiring unit 501, and then select a first precoding matrix for performing data precoding from the second codebook set;
a transmitting unit 503, configured to carry an index corresponding to the first precoding matrix selected by the selecting unit 502 over the transmission channel to transmit.

[0041] Description of corresponding methods of Figs. 3 and 4 above can be referenced for interactions between various modules of the above UE and the BS, and particular implementation of functions of those various modules.

[0042] In this embodiment, after the UE acquires transmission channel capability, a codebook set used thereon can be configured according to the channel capability, and PMI can be feedback to the BS, so that the BS can obtained PMI with different accuracies depending on carrying capabilities of UE transmission channels.

[0043] Fig.6 is a schematic structural diagram of a BS according to an embodiment of this invention, capable of realizing the method provided in the embodiment above, the BS including:

a receiving unit 601, configured to receive an index corresponding to a first precoding matrix transmitted by a UE through a transmission channel, wherein the first precoding matrix is selected from a second codebook set by the UE, and the second codebook set is formed from precoding matrixes selected from a first codebook set locally stored on the UE;
a precoding unit 602, configured to search for the first precoding matrix in a third codebook set locally stored according to the index received by the receiving unit 601, and perform precoding on data according to the first precoding matrix, wherein the third codebook set is identical to the second codebook set.

[0044] In another embodiment of this invention, the BS further includes:
a transmitting unit 603, configured to transmit to the UE a signaling for notifying the UE of the capability of the transmission channel to carry PMI, so as to enable the UE to select precoding matrixes from the first codebook set to form the second codebook set. The UE and the BS can also predetermine the capabilities of the transmission channels to carry PMI in advance.

[0045] Description of corresponding methods of Figs. 3 and 4 above can be referenced for interactions between various modules of the above UE and the BS, and particular implementation of functions of those various modules.

[0046] In this embodiment, the BS can set up PMI feedback capabilities of different transmission channels of a UE as required, so as to obtain PMI with different accuracies.

[0047] Note that all or some of above units can be integrated in a chip. Various functional units according to each embodiment of the present invention may be integrated in one processing module or may exist as separate physical units, or two or more units may also be integrated in one unit. The integrated module may be implemented through hardware, or may also be implemented in a form of a software functional module. When the integrated module is implemented in the form of the software functional module and sold or used as a separate product, the integrated module may be stored in a computer readable storage medium. The storage medium mentioned above may be ROM, a magnet disc or an optical disc.

[0048] The accompanying drawings and related description are merely for the illustration of the principle of this invention, and are not intended to limit the scope of this invention. For example, message names and entities in various embodiments can vary with networks, and some messages can be omitted. The present invention is defined and limited only by the scope of the appended claims.

Claims

1. A method for transmitting a precoding matrix index, PMI, said method comprising:

    acquiring (301), by a user equipment, UE, a capability of a physical uplink control channel, PUCCH, to carry said PMI, and wherein the capability of a PUCCH to carry said PMI refers to a number of bits that the PUCCH can use to transmit said PMI;
    forming (302), by the UE, a second codebook set as a subset of a first codebook set according to the capability of said PUCCH to carry said PMI, the first codebook set being locally stored on the UE;
    selecting (303), by the UE, a first precoding matrix from the second codebook set; and
    transmitting (304), by the UE, an index item corresponding to the selected first precoding matrix to a base station, BS, over the PUCCH.

2. The method according to claim 1, wherein the second codebook set meets a criterion of uniformly partitioning the signal space.

3. The method according to claim 1 or 2, wherein each precoding matrix in the first codebook set locally stored is

represented as $W = W_1 W_2$, wherein, $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}, \quad \mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 is a $N_t \times 2R$ matrix,
W_2 is a $2R \times R$ matrix,
I is a $R \times R$ identity matrix,
X is a $R \times R$ diagonal matrix,
D is a $N_t/2 \times N_t/2$ diagonal matrix,
A is a $N_t/2 \times R$ matrix,
A is a $R \times R$ diagonal matrix,
wherein N_t is even and represents the number of transmission antennas of the BS, R is the rank of said each precoding matrix.

4. The method according to claim 3, wherein, when the rank is 1, and D and X are identity matrixes, the method comprises:
representing Λ with 1 bit having a value of 1 or -1.

5. The method according to claim 3, wherein, when the rank is 1, and D and X are identity matrixes, the method comprises:
representing A with 3 bits, to indicate 8 uniform directions.

6. A method for precoding, comprising:

receiving (401), by a base station, BS, an index item corresponding to a first precoding matrix, PMI, transmitted by a user equipment, UE, over a physical uplink control channel, PUCCH, wherein,
the first precoding matrix is selected by the UE from a second codebook set, wherein the second codebook set is formed by the UE as a subset of a first codebook set according to a capability of the PUCCH to carry said PMI, and wherein the capability of the PUCCH to carry said PMI refers to a number of bits that the PUCCH can use to transmit said PMI, and the first codebook set is locally stored on the UE;
searching for (402), by the BS, the first precoding matrix according to the index item; and
performing(403), by the BS, precoding on data according to the first precoding matrix.

7. The method according to claim 6, wherein the second codebook set meets a criterion of uniformly partitioning the signal space.

8. The method according to claim 6 or 7, wherein each precoding matrix in the first codebook set is represented as $W = W_1 W_2$, wherein, $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}, \quad \mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 is a $N_t \times 2R$ matrix,
W_2 is a $2R \times R$ matrix,
I is a $R \times R$ identity matrix,
X is a $R \times R$ diagonal matrix,
D is a $N_t/2 \times N_t/2$ diagonal matrix,
A is a $N_t/2 \times R$ matrix,
Λ is a $R \times R$ diagonal matrix,
wherein N_t is even and represents the number of transmission antennas of the BS, R is the rank of said each precoding matrix.

9. The method according to claim 8, wherein, when the rank is 1, and D and X are identity matrixes, the method comprises:
representing Λ with 1 bit having a value of 1 or -1.

10. The method according to claim 8, wherein, when the rank is 1, and D and X are identity matrixes, the method

comprises:
representing A with 3 bits, to indicate 8 uniform directions.

11. A user equipment, UE, comprising:

an acquiring unit (501), configured to acquire a capability of a physical uplink control channel, PUCCH, to carry a precoding matrix index, PMI, and wherein the capability of a PUCCH to carry a PMI refers to a number of bits that the PUCCH can use to transmit said PMI;
a selecting unit (502), configured to form a second codebook set as a subset of a first codebook set according to the capability of a PUCCH to carry said PMI, the first codebook set being locally stored on the UE, and select a first precoding matrix from the second codebook set; and
a transmitting unit (503), configured to transmit an index item corresponding to the selected first precoding matrix to a base station (BS) over the PUCCH.

12. The UE according to claim 11, wherein, the second codebook set meets a criterion of uniformly partitioning the signal space.

13. The UE according to claim 11 or 12, wherein, each precoding matrix in the first codebook set is represented as $W = W_1W_2$, wherein, $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}$, $\mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 is a $N_t \times 2R$ matrix,
W_2 is a $2R \times R$ matrix,
I is a $R \times R$ identity matrix,
X is a $R \times R$ diagonal matrix,
D is a $N_t/2 \times N_t/2$ diagonal matrix,
A is a $N_t/2 \times R$ matrix,
Λ is a $R \times R$ diagonal matrix,
wherein N_t is even and represents the number of transmission antennas of the BS, R is the rank of said each precoding matrix.

14. The UE according to claim 13, wherein, when the rank is 1, the second codebook set is a subset of the first codebook set, and D and X are identity matrixes, the method comprises:
representing Λ with 1 bit having a value of 1 or -1.

15. The UE according to claim 13, wherein, when the rank is 1, the second codebook set is a subset of the first codebook set, and D and X are identity matrixes, the method comprises:
representing A with 3 bits, to indicate 8 uniform directions.

16. A base station, BS, comprising:

a receiving unit (601), configured to receive an index item corresponding to a first precoding matrix, PMI, transmitted by a user equipment, UE, over a physical uplink control channel, PUCCH, wherein,
the first precoding matrix is selected by the UE from a second codebook set, wherein the second codebook set is formed by the UE as a subset of a first codebook set according to a capability of the PUCCH to carry said PMI, and wherein the capability of the PUCCH to carry said PMI refers to a number of bits that the PUCCH can use to transmit said PMI, and the first codebook set is locally stored on the UE;
a precoding unit (602), configured to search for the first precoding matrix in a third codebook set locally stored by the BS according to the index item received by the receiving unit, and perform precoding on data according to the first precoding matrix, wherein the third codebook set is identical to the second codebook set.

17. The BS according to claim 16, wherein the second codebook set meets a criterion of uniformly partitioning the signal space.

18. The BS according to claim 16 or 17, wherein each precoding matrix in the first codebook set is represented as W

$= W_1 W_2$, wherein, $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}$, $\mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 is a $N_t \times 2R$ matrix,
W_2 is a $2R \times R$ matrix,
I is a $R \times R$ identity matrix,
X is a $R \times R$ diagonal matrix,
D is a $N_t/2 \times N_t/2$ diagonal matrix,
A is a $N_t/2 \times R$ matrix,
Λ is a $R \times R$ diagonal matrix,
wherein N_t is even and represents the number of transmission antennas of the BS, R is the rank of said each precoding matrix.

19. The BS according to claim 18, wherein, when the rank is 1, and D and X are identity matrixes, the method comprises: representing Λ with 1 bit having a value of 1 or -1.

20. The BS according to claim 18, wherein, when the rank is 1, and D and X are identity matrixes, the method comprises: representing A with 3 bits, to indicate 8 uniform directions.

Patentansprüche

1. Verfahren zum Übertragen eines Vorcodierungsmatrixindexes bzw. PMI, wobei das Verfahren Folgendes umfasst:

Erfassen (301), durch ein Benutzergerät bzw. UE, einer Fähigkeit eines physischen Aufwärtsstreckensteuerkanals bzw. PUCCH, den PMI zu führen, und wobei sich die Fähigkeit eines PUCCH, den PMI zu führen, auf eine Anzahl von Bits bezieht, die der PUCCH zum Übertragen des PMI verwenden kann;
Bilden (302), durch das UE, einer zweiten Codebuchmenge als eine Teilmenge einer ersten Codebuchmenge gemäß der Fähigkeit des PUCCH, den PMI zu führen, wobei die erste Codebuchmenge lokal auf dem UE gespeichert ist;
Auswählen (303), durch das UE, einer ersten Vorcodierungsmatrix aus der zweiten Codebuchmenge und Übertragen (304), durch das UE, eines Indexelements, das der ausgewählten ersten Vorcodierungsmatrix entspricht, zu einer Basisstation bzw. BS über den PUCCH.

2. Verfahren nach Anspruch 1, wobei die zweite Codebuchmenge ein Kriterium des gleichmäßigen Partitionierens des Signalraums erfüllt.

3. Verfahren nach Anspruch 1 oder 2, wobei jede Vorcodierungsmatrix in der lokal gespeicherten ersten Codebuchmenge als $W = W_1 W_2$ repräsentiert wird, wobei $W_1 = \begin{pmatrix} \mathrm{DA} & 0 \\ 0 & \mathrm{DA\Lambda} \end{pmatrix}$, $W_2 = \begin{pmatrix} \mathrm{I} \\ \mathrm{X} \end{pmatrix}$,

W_1 eine $N_t \times 2R$-Matrix ist,
W_2 eine $2R \times$ R-Matrix ist,
I eine $R \times R$-Einheitsmatrix ist,
X eine $R \times R$-Diagonalmatrix ist,
D eine $N_t/2 \times N_t/2$-Diagonalmatrix ist,
A eine $N_t/2 \times R$-Matrix ist,
Λ eine $R \times R$-Diagonalmatrix ist,
wobei N_t gerade ist und die Anzahl von Übertragungsantennen der BS repräsentiert,
wobei R der Rang jeder Vorcodierungsmatrix ist.

4. Verfahren nach Anspruch 3, wobei, wenn der Rang 1 ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:
Repräsentieren von A mit 1 Bit, das einen Wert von 1 oder -1 aufweist.

5. Verfahren nach Anspruch 3, wobei, wenn der Rang 1 ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes

umfasst:
Repräsentieren von A mit 3 Bits, um 8 einheitliche Richtungen anzugeben.

6. Verfahren zur Vorcodierung, das Folgendes umfasst:

Empfangen (401), durch eine Basisstation bzw. BS, eines Indexelements, das einer ersten Vorcodierungsmatrix entspricht, PMI, das durch ein Benutzergerät bzw. UE über einen physischen Aufwärtsstreckensteuerkanal bzw. PUCCH übertragen wird, wobei
die erste Vorcodierungsmatrix durch das UE aus einer zweiten Codebuchmenge ausgewählt wird, wobei die zweite Codebuchmenge durch das UE als eine Teilmenge einer ersten Codebuchmenge gemäß einer Fähigkeit des PUCCH, das PMI zu führen, gebildet wird und wobei sich die Fähigkeit des PUCCH, das PMI zu führen, auf eine Anzahl von Bits bezieht, die der PUCCH zum Übertragen des PMI verwenden kann, und die erste Codebuchmenge lokal auf dem UE gespeichert ist;
Suchen (402), durch die BS, nach der ersten Vorcodierungsmatrix gemäß dem Indexelement und
Durchführen (403), durch die BS, einer Vorcodierung an Daten gemäß der ersten Vorcodierungsmatrix.

7. Verfahren nach Anspruch 6, wobei die zweite Codebuchmenge ein Kriterium des einheitlichen Partitionierens des Signalraums erfüllt.

8. Verfahren nach Anspruch 6 oder 7, wobei jede Vorcodierungsmatrix in der ersten Codebuchmenge als $W = W_1W_2$ repräsentiert wird, wobei $W_1 = \begin{pmatrix} \mathrm{DA} & 0 \\ 0 & \mathrm{DA\Lambda} \end{pmatrix}$, $W_2 = \begin{pmatrix} \mathrm{I} \\ \mathrm{X} \end{pmatrix}$,

W_1 eine $N_t \times 2R$-Matrix ist,
W_2 eine $2R \times R$-Matrix ist,
I eine $R \times R$-Einheitsmatrix ist,
X eine $R \times R$-Diagonalmatrix ist,
D eine $N_t/2 \times N_t/2$-Diagonalmatrix ist,
A eine $N_t/2 \times$ R-Matrix ist,
Λ eine $R \times R$-Diagonalmatrix ist,
wobei N_t gerade ist und die Anzahl von Übertragungsantennen der BS repräsentiert,
wobei R der Rang jeder Vorcodierungsmatrix ist.

9. Verfahren nach Anspruch 8, wobei, wenn der Rang 1 ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:
Repräsentieren von A mit 1 Bit, das einen Wert von 1 oder -1 aufweist.

10. Verfahren nach Anspruch 8, wobei, wenn der Rang 1 ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:
Repräsentieren von A mit 3 Bits, um 8 einheitliche Richtungen anzugeben.

11. Benutzergerät bzw. UE, das Folgendes umfasst:

eine Erfassungseinheit (501), die konfiguriert ist zum Erfassen einer Fähigkeit eines physischen Aufwärtsstreckensteuerkanals bzw. PUCCH, einen Vorcodierungsmatrixindex bzw. PMI zu führen, und wobei sich die Fähigkeit eines PUCCH, den PMI zu führen, auf eine Anzahl von Bits bezieht, die der PUCCH zum Übertragen des PMI verwenden kann;
eine Auswahleinheit (502), die konfiguriert ist zum Bilden einer zweiten Codebuchmenge als eine Teilmenge einer ersten Codebuchmenge gemäß der Fähigkeit des PUCCH, den PMI zu führen, wobei die erste Codebuchmenge lokal auf dem UE gespeichert ist, und zum Auswählen einer ersten Vorcodierungsmatrix aus der zweiten Codebuchmenge; und
eine Übertragungseinheit (503), die konfiguriert ist zum Übertragen eines Indexelements, das der ausgewählten ersten Vorcodierungsmatrix entspricht, zu einer Basisstation (BS) über den PUCCH.

12. UE nach Anspruch 11, wobei die zweite Codebuchmenge ein Kriterium des gleichmäßigen Partitionierens des Signalraums erfüllt.

13. UE nach Anspruch 11 oder 12, wobei jede Vorcodierungsmatrix in der ersten Codebuchmenge als $W = W_1W_2$ repräsentiert wird, wobei $W_1 = \begin{pmatrix} \mathrm{DA} & 0 \\ 0 & \mathrm{DA\Lambda} \end{pmatrix}, W_2 = \begin{pmatrix} \mathrm{I} \\ \mathrm{X} \end{pmatrix},$

W_1 eine $N_t \times 2R$-Matrix ist,
W_2 eine $2R \times R$-Matrix ist,
I eine $R \times R$-Einheitsmatrix ist,
X eine $R \times R$-Diagonalmatrix ist,
D eine $N_t/2 \times N_t/2$-Diagonalmatrix ist,
A eine $N_t/2 \times R$-Matrix ist,
Λ eine $R \times R$-Diagonalmatrix ist,
wobei N_t gerade ist und die Anzahl von Übertragungsantennen der BS repräsentiert, wobei R der Rang jeder Vorcodierungsmatrix ist.

14. UE nach Anspruch 13, wobei, wenn der Rang 1 ist, die zweite Codebuchmenge eine Teilmenge der ersten Codebuchmenge ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:
Repräsentieren von A mit 1 Bit, das einen Wert von 1 oder -1 aufweist.

15. UE nach Anspruch 13, wobei, wenn der Rang 1 ist, die zweite Codebuchmenge eine Teilmenge der ersten Codebuchmenge ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:
Repräsentieren von A mit 3 Bits, um 8 einheitliche Richtungen anzugeben.

16. Basisstation bzw. BS, die Folgendes umfasst:

eine Empfangseinheit (601), die konfiguriert ist zum Empfangen eines Indexelements, das einer ersten Vorcodierungsmatrix entspricht, PMI, das durch ein Benutzergerät bzw. UE über einen physischen Aufwärtsstreckensteuerkanal bzw. PUCCH übertragen wird, wobei
die erste Vorcodierungsmatrix durch das UE aus einer zweiten Codebuchmenge ausgewählt wird, wobei die zweite Codebuchmenge durch das UE als eine Teilmenge einer ersten Codebuchmenge gemäß einer Fähigkeit des PUCCH, das PMI zu führen, gebildet wird und wobei sich die Fähigkeit des PUCCH, das PMI zu führen, auf eine Anzahl von Bits bezieht, die der PUCCH zum Übertragen des PMI verwenden kann, und die erste Codebuchmenge lokal auf dem UE gespeichert ist;
eine Vorcodierungseinheit (602), die konfiguriert ist zum Suchen nach der ersten Vorcodierungsmatrix in einer dritten Codebuchmenge, die durch die BS lokal gespeichert wird, gemäß dem Indexelement, das durch die Empfangseinheit empfangen wird, und zum Durchführen einer Vorcodierung an Daten gemäß der ersten Vorcodierungsmatrix, wobei die dritte Codebuchmenge identisch zur zweiten Codebuchmenge ist.

17. BS nach Anspruch 16, wobei die zweite Codebuchmenge ein Kriterium des gleichmäßigen Partitionierens des Signalraums erfüllt.

18. BS nach Anspruch 16 oder 17, wobei jede Vorcodierungsmatrix in der ersten Codebuchmenge als $W = W_1W_2$ repräsentiert wird, wobei $W_1 = \begin{pmatrix} \mathrm{DA} & 0 \\ 0 & \mathrm{DA\Lambda} \end{pmatrix}, W_2 = \begin{pmatrix} \mathrm{I} \\ \mathrm{X} \end{pmatrix},$

W_1 eine $N_t \times 2R$-Matrix ist,
W_2 eine $2R \times R$-Matrix ist,
I eine $R \times R$-Einheitsmatrix ist,
X eine $R \times R$-Diagonalmatrix ist,
D eine $N_t/2 \times N_t/2$-Diagonalmatrix ist,
A eine $N_t/2 \times R$-Matrix ist,
Λ eine $R \times R$-Diagonalmatrix ist,
wobei N_t gerade ist und die Anzahl von Übertragungsantennen der BS repräsentiert,
wobei R der Rang jeder Vorcodierungsmatrix ist.

19. BS nach Anspruch 18, wobei, wenn der Rang 1 ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:

Repräsentieren von Λ mit 1 Bit, das einen Wert von 1 oder -1 aufweist.

20. BS nach Anspruch 18, wobei, wenn der Rang 1 ist und D und X Einheitsmatrizen sind, das Verfahren Folgendes umfasst:
Repräsentieren von A mit 3 Bits, um 8 einheitliche Richtungen anzugeben.

Revendications

1. Procédé d'émission d'un index de matrice de précodage, PMI, ledit procédé comprenant les étapes consistant à :

acquérir (301), par un équipement d'utilisateur, UE, une capacité d'un canal de commande de liaison montante physique, PUCCH, à transporter ledit PMI, la capacité d'un PUCCH à transporter ledit PMI se rapportant à un nombre de bits que le PUCCH peut utiliser pour émettre ledit PMI ;
former (302), par l'UE, un deuxième ensemble de livres de code constituant un sous-ensemble d'un premier ensemble de livres de code en fonction de la capacité dudit PUCCH à transporter ledit PMI, le premier ensemble de livres de code étant stocké localement sur l'UE ;
sélectionner (303), par l'UE, une première matrice de précodage dans le deuxième ensemble de livres de code ; et
émettre (304), par l'UE, un élément d'index correspondant à la première matrice de précodage sélectionnée vers une station de base, BS, sur le PUCCH.

2. Procédé selon la revendication 1, dans lequel le deuxième ensemble de livres de code satisfait à un critère de partitionnement uniforme de l'espace de signal.

3. Procédé selon la revendication 1 ou 2, dans lequel chaque matrice de précodage du premier ensemble de livres de code stocké localement est représentée sous la forme $W = W_1W_2$, où

$$\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}, \quad \mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix},$$

W_1 est une matrice $N_t \times 2R$,
W_2 est une matrice $2R \times R$,
I est une matrice identité $R \times R$,
X est une matrice diagonale $R \times R$,
D est une matrice diagonale $N_t/2 \times N_t/2$,
A est une matrice $N_t/2 \times R$,
Λ est une matrice diagonale $R \times R$,
où N_t est pair et représente le nombre d'antennes d'émission de la BS, R est le rang de chacune desdites matrices de précodage.

4. Procédé selon la revendication 3, le procédé, lorsque le rang est 1 et que D et X sont des matrices identité, comprenant l'étape consistant à :
représenter Λ avec 1 bit ayant la valeur 1 ou -1.

5. Procédé selon la revendication 3, le procédé, lorsque le rang est 1 et que D et X sont des matrices identité, comprenant l'étape consistant à :
représenter A avec 3 bits pour indiquer 8 directions uniformes.

6. Procédé de précodage, comprenant les étapes consistant à :

recevoir (401), par une station de base, BS, un élément d'index correspondant à une première matrice de précodage, PMI, émise par un équipement d'utilisateur, UE, sur un canal de commande de liaison montante physique, PUCCH,
la première matrice de précodage étant sélectionnée par l'UE dans un deuxième ensemble de livres de code, le deuxième ensemble de livres de code étant formé par l'UE en tant que sous-ensemble d'un premier ensemble

de livres de code en fonction d'une capacité du PUCCH à transporter ledit PMI, la capacité du PUCCH à transporter ledit PMI se rapportant à un nombre de bits que le PUCCH peut utiliser pour émettre ledit PMI, et le premier ensemble de livres de code étant stocké localement sur l'UE ; rechercher (402), par la BS, la première matrice de précodage en fonction de l'élément d'index ; et
effectuer (403), par la BS, un précodage sur les données d'après la première matrice de précodage.

7. Procédé selon la revendication 6, dans lequel le deuxième ensemble de livres de code satisfait à un critère de partitionnement uniforme de l'espace de signal.

8. Procédé selon la revendication 6 ou 7, dans lequel chaque matrice de précodage du premier ensemble de livres de code est représentée sous la forme $W = W_1W_2$, où $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}$, $\mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 est une matrice $N_t \times 2R$,
W_2 est une matrice $2R \times R$,
I est une matrice identité $R \times R$,
X est une matrice diagonale $R \times R$,
D est une matrice diagonale $N_t/2 \times N_t/2$,
A est une matrice $N_t/2 \times R$,
Λ est une matrice diagonale $R \times R$,
où N_t est pair et représente le nombre d'antennes d'émission de la BS, R est le rang de chacune desdites matrices de précodage.

9. Procédé selon la revendication 8, le procédé, lorsque le rang est 1 et que D et X sont des matrices identité, comprenant l'étape consistant à :
représenter A avec 1 bit ayant la valeur 1 ou -1.

10. Procédé selon la revendication 8, le procédé, lorsque le rang est 1 et que D et X sont des matrices identité, comprenant l'étape consistant à :
représenter A avec 3 bits pour indiquer 8 directions uniformes.

11. Équipement d'utilisateur, UE, comprenant :

une unité d'acquisition (501), conçue pour acquérir une capacité d'un canal de commande de liaison montante physique, PUCCH, à transporter un index de matrice de précodage, PMI, la capacité d'un PUCCH à transporter un PMI se rapportant à un nombre de bits que le PUCCH peut utiliser pour émettre ledit PMI ;
une unité de sélection (502), conçue pour former un deuxième ensemble de livres de code constituant un sous-ensemble d'un premier ensemble de livres de code en fonction de la capacité d'un PUCCH à transporter ledit PMI, le premier ensemble de livres de code étant stocké localement sur l'UE, et sélectionner une première matrice de précodage dans le deuxième ensemble de livres de code ; et
une unité d'émission (503), conçue pour émettre un élément d'index correspondant à la première matrice de précodage sélectionnée vers une station de base, BS, sur le PUCCH.

12. UE selon la revendication 11, dans lequel le deuxième ensemble de livres de code satisfait à un critère de partitionnement uniforme de l'espace de signal.

13. UE selon la revendication 11 ou 12, dans lequel chaque matrice de précodage du premier ensemble de livres de code est représentée sous la forme $W = W_1W_2$, où $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}$, $\mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 est une matrice $N_t \times 2R$,
W_2 est une matrice $2R \times R$,
I est une matrice identité $R \times R$,
X est une matrice diagonale $R \times R$,

D est une matrice diagonale $N_t/2 \times N_t/2$,
A est une matrice $N_t/2 \times R$,
Λ est une matrice diagonale $R \times R$,
où N_t est pair et représente le nombre d'antennes d'émission de la BS, R est le rang de chacune desdites matrices de précodage.

14. UE selon la revendication 13, dans lequel, lorsque le rang est 1, que le deuxième ensemble de livres de code est un sous-ensemble du premier ensemble de livres de code et que D et X sont des matrices identité, le procédé comprend l'étape consistant à :
représenter Λ avec 1 bit ayant la valeur 1 ou -1.

15. UE selon la revendication 13, dans lequel, lorsque le rang est 1, que le deuxième ensemble de livres de code est un sous-ensemble du premier ensemble de livres de code et que D et X sont des matrices identité, le procédé comprend l'étape consistant à :
représenter A avec 3 bits pour indiquer 8 directions uniformes.

16. Station de base, BS, comprenant :

une unité de réception (601), conçue pour recevoir un élément d'index correspondant à une première matrice de précodage, PMI, émise par un équipement d'utilisateur, UE, sur un canal de commande de liaison montante physique, PUCCH,
la première matrice de précodage étant sélectionnée par l'UE dans un deuxième ensemble de livres de code, le deuxième ensemble de livres de code étant formé par l'UE en tant que sous-ensemble d'un premier ensemble de livres de code en fonction d'une capacité du PUCCH à transporter ledit PMI, la capacité du PUCCH à transporter ledit PMI se rapportant à un nombre de bits que le PUCCH peut utiliser pour émettre ledit PMI, et le premier ensemble de livres de code étant stocké localement sur l'UE ;
une unité de précodage (602), conçue pour rechercher la première matrice de précodage dans un troisième ensemble de livres de code stocké localement par la BS d'après l'élément d'index reçu par l'unité de réception, et effectuer un précodage sur les données d'après la première matrice de précodage, le troisième ensemble de livres de code étant identique au deuxième ensemble de livres de code.

17. BS selon la revendication 16, dans laquelle le deuxième ensemble de livres de code satisfait à un critère de partitionnement uniforme de l'espace de signal.

18. BS selon la revendication 16 ou 17, dans laquelle chaque matrice de précodage du premier ensemble de livres de code est représentée sous la forme $W = W_1W_2$, où $\mathbf{W}_1 = \begin{pmatrix} \mathbf{DA} & 0 \\ 0 & \mathbf{DA\Lambda} \end{pmatrix}$, $\mathbf{W}_2 = \begin{pmatrix} \mathbf{I} \\ \mathbf{X} \end{pmatrix}$,

W_1 est une matrice $N_t \times 2R$,
W_2 est une matrice $2R \times R$,
I est une matrice identité $R \times R$,
X est une matrice diagonale $R \times R$,
D est une matrice diagonale $N_t/2 \times N_t/2$,
A est une matrice $N_t/2 \times R$,
Λ est une matrice diagonale $R \times R$,
où N_t est pair et représente le nombre d'antennes d'émission de la BS, R est le rang de chacune desdites matrices de précodage.

19. BS selon la revendication 18, dans laquelle, lorsque le rang est 1 et que D et X sont des matrices identité, le procédé comprend l'étape consistant à :
représenter A avec 1 bit ayant la valeur 1 ou -1.

20. BS selon la revendication 18, dans laquelle, lorsque le rang est 1 et que D et X sont des matrices identité, le procédé comprend l'étape consistant à :
représenter A avec 3 bits pour indiquer 8 directions uniformes.

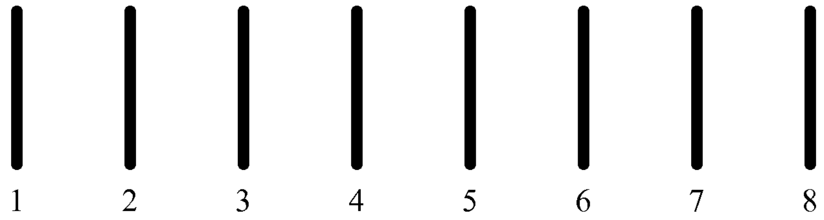

Fig.1

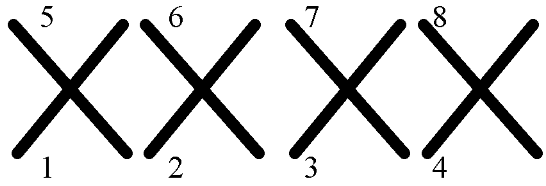

Fig.2

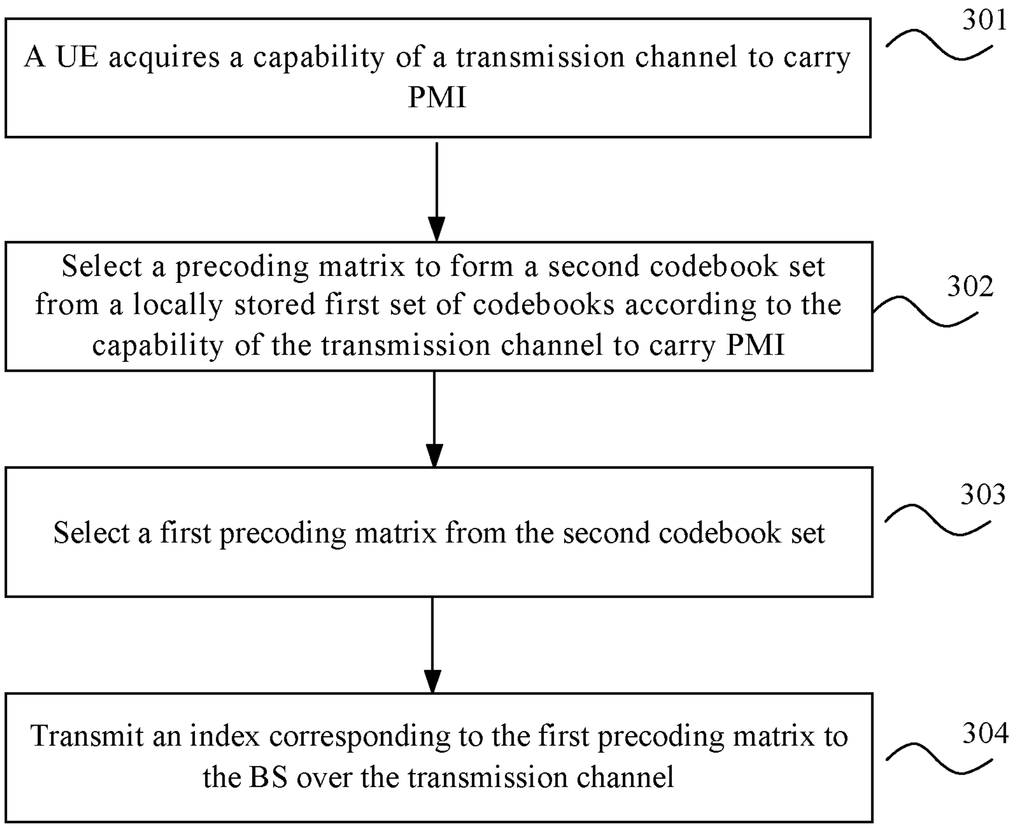
A UE acquires a capability of a transmission channel to carry PMI
301
Select a precoding matrix to form a second codebook set from a locally stored first set of codebooks according to the capability of the transmission channel to carry PMI
302
Select a first precoding matrix from the second codebook set
303
Transmit an index corresponding to the first precoding matrix to the BS over the transmission channel
304

Fig.3

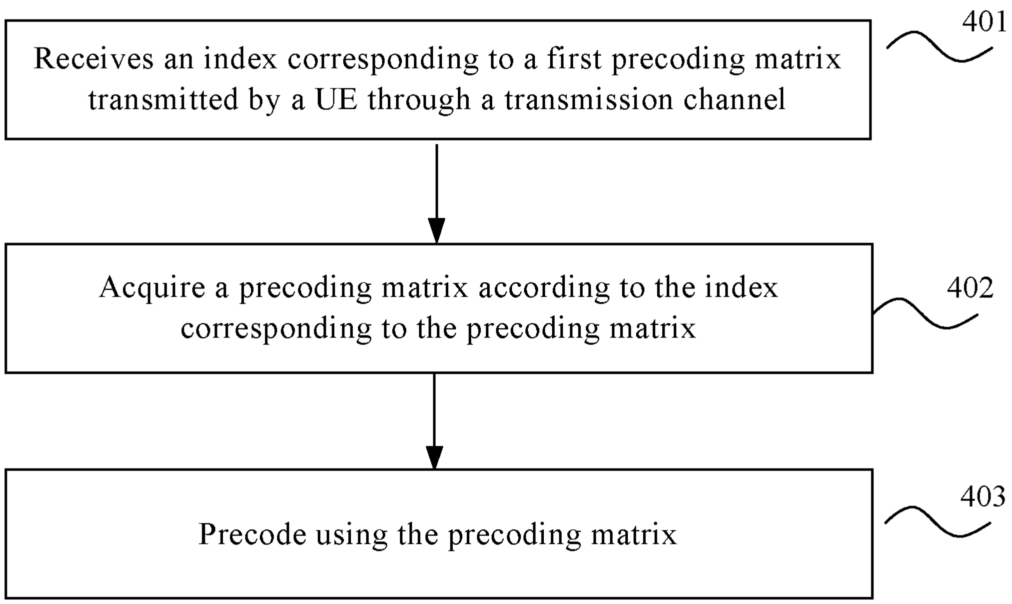
Receives an index corresponding to a first precoding matrix transmitted by a UE through a transmission channel
401
Acquire a precoding matrix according to the index corresponding to the precoding matrix
402
Precode using the precoding matrix
403

Fig.4

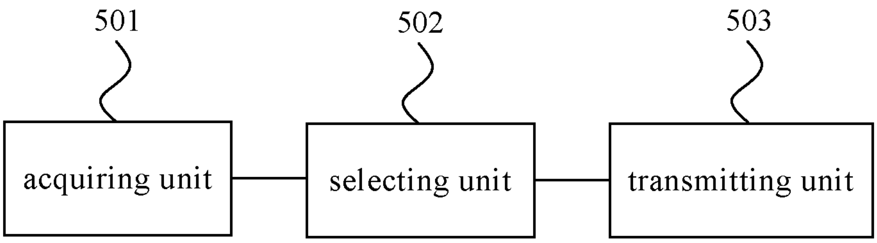
501
502
503
acquiring unit
selecting unit
transmitting unit

Fig. 5

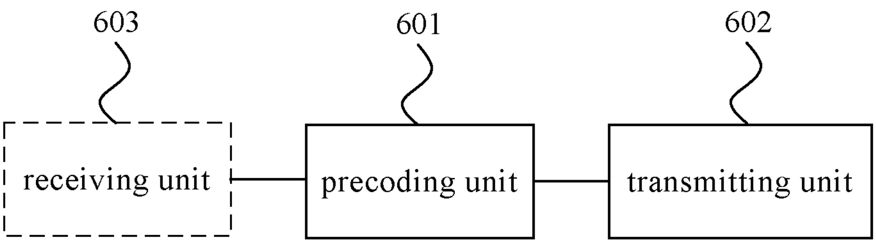
603
601
602
receiving unit
precoding unit
transmitting unit

Fig.6

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- **HUAWEI.** Downlink 8TX codebook considerations. *3GPP DRAFT; R1-100256,* 12 January 2010 **[0005]**
- **HUAWEI.** Extensions to Rel-8 type CQI/PMI/RI feedback using double codebook structure. *3GPP DRAFT; R1-100251,* 12 January 2010 **[0006]**